Space Weather Technical Forecast

Issued on Thursday, 28 April 2022 at 12:11 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1/Minor Storms Likely 29th and 30th, chance of G2/Moderate Storms 30th. Chance of M-class flares (R1/R2 Radio Blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with several C-class flares observed, the most recent a C6.7 from ex-2996 in the northwest quadrant at 28/0306 UTC. An associated CME was observed and appears directed off the Sun-Earth line, with analysis pending to confirm this.

There are currently eight numbered sunspot regions on the visible disc. AR2994 (Eho/Beta-Gamma) in the far northwestern quadrant remains the most complex. The remaining sunspot groups are all rather simple with mostly small magnetic regions, or are benign alpha spots.

Several other CME's have been observed in LASCO and STEREO-A imagery, with one originating from the C7 flare at 1450UTC on 27th currently expected to be Earth directed, with arrival on 30th April. A prominence eruption was observed off the southeast limb, beginning around 28/0300UTC, with the associated CME looking directed off the Sun-Earth line. However, analysis will be conducted as more imagery becomes available to confirm this.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1, increased to 480-500km/s (elevated) around 27/1200UTC likely indicating the arrival of a CME. Density was around Average levels for much of the period with a brief peak above average at around 27/1330UTC, with a max of 30ppcc. The Interplanetary Magnetic Field (IMF) Bt was mostly weak but with an initial short period of moderate, rising to a max of 12nT at 27/1259UTC. The north-south component, Bz, followed a similar trend, with an initial extended period of negative polarity, peaking at -11nT. The phi angle was mostly negative (towards the Sun), but rotated to positive (away from the sun) during the afternoon UTC of 27th. Geomagnetic activity started at G1/Minor Storm interval (Kp 5) 27/1200-1500UTC, then became Unsettled to Active (Kp 3-4) thereafter.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) was at background levels throughout. The high energy electron flux (greater than 2MeV) has been at background to moderate levels throughout, following an expected diurnal trend. The associated 24 hour fluence was below the Active (1e8 integrated pfu) level on a generally steady trend, with 1.14e7 integrated pfu recorded at 28/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low, with a chance of Moderate activity and a very slight chance of High activity.

Solar Wind / Geomagnetic Activity: Current modelling suggests the arrival of a CME which left the Sun around 27/1450UTC, early on 30th April. Solar winds are expected to be slightly elevated to elevated speeds through 28 April with a slight decreasing trend. Speeds are then

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forecast to increase to 500-550km/s either late on 28 April or more likely on 29 April due to the onset of the high speed stream from Coronal Hole 78. Speeds may then increase further to 550-600 km/s at the CME arrival early on 30th. Speeds will then likely decrease later on 30th or 1st May back to 450-500km/s. Geomagnetic activity is forecast to be mainly Quiet to Unsettled on 28th with a chance of Active intervals and a slight chance of G1/Minor Storm intervals. Activity will then likley increase to Unsettled to Active on 29th with a chance of G1/Minor Storm intervals. Early on 30th April the geomagnetic activity will likely increase to G1/Minor Storm, with a chance of G2/Moderate Storm intervals before easing back to Quiet to Active later on 30th and during 1st May.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is at background levels, and is most likely to remain so through the next four days. The high energy electron flux (greater than 2MeV) is expected to be at mainly background to moderate levels, but with a trend towards the high (1e3 pfu) threshold possible on 01 May. Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold but with a rising trend late in the period.

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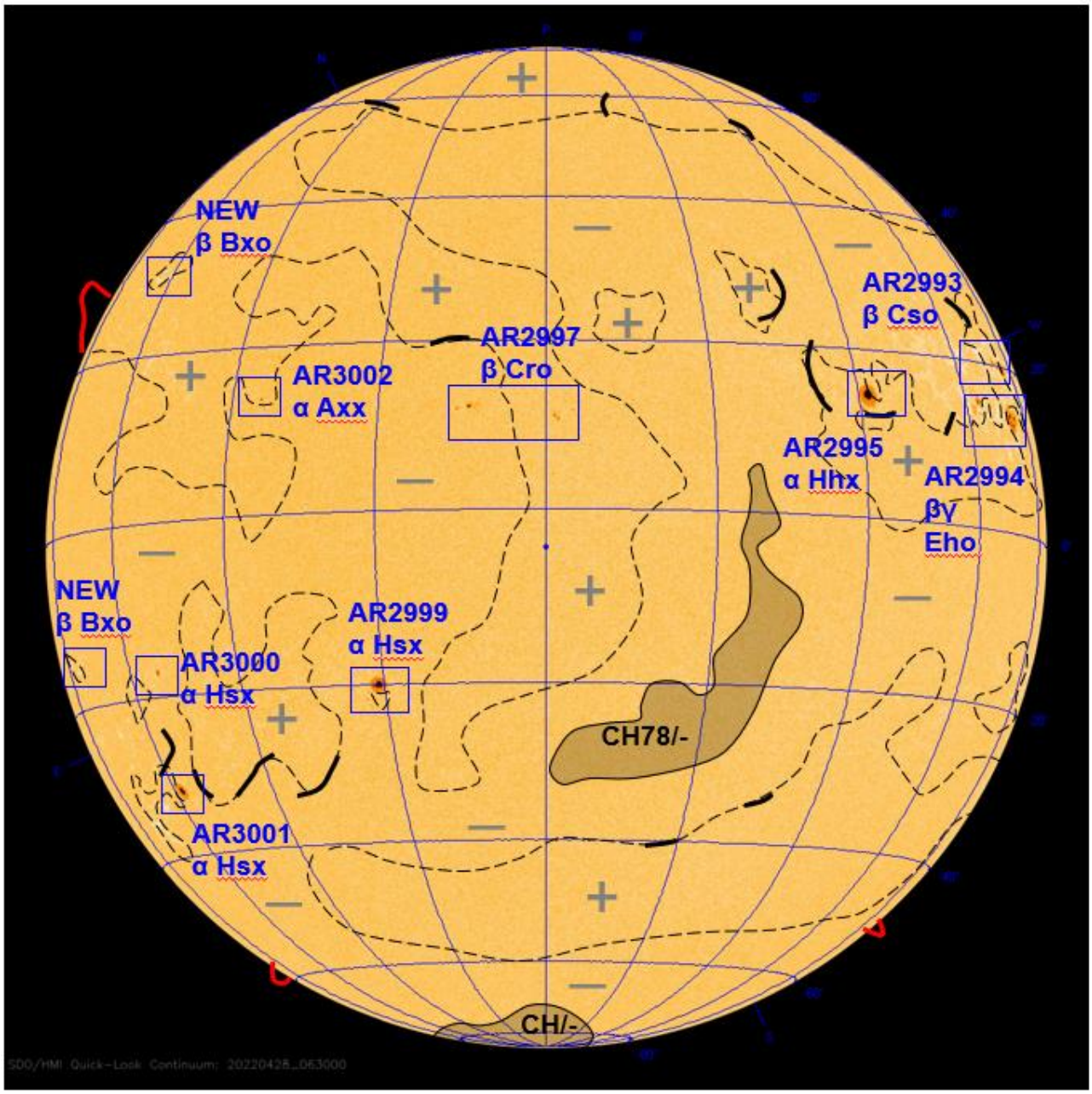
Figure 1. Solar Analysis Valid 28/0700UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A CME is expected to arrive at Earth early on 30th April. This CME originated form a long period C7 flare in the northern hemisphere of the Sun, peaking around 1450UTC on 27th April. It's positioning and lack of imagery has meant that several analyses have taken place, with below average confidence in the detail. Although, evidence suggests that this CME may catch up with another CME released from a similar position a number of hours earlier, perhaps gathering material. Its initial velocity was around 800-900km/s but this will likely become 550-600km/s (chance of 650km/s) upon arrival at L1 and Earth.

Solar winds are currently on the border between slightly elevated and elevated, but are expected to be on a slight decreasing trend during 28th. Speeds are then forecast to increase to 500-550km/s either late on 28 April or more likely on 29 April due to the onset of the high speed stream from Coronal Hole 78, though ENLIL is suggesting a modification to this CH arrival due to CME effects, though this detail is low confidence. Post CME, solar wind speeds are then expected to fall back to slightly elevated by 01 May.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	40	70	10
Strong	G3	No	1	1	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
27/2138	Partial	C7 flare	NW quadrant	830	30/0200 +/- 6hrs	Possible glancing blow

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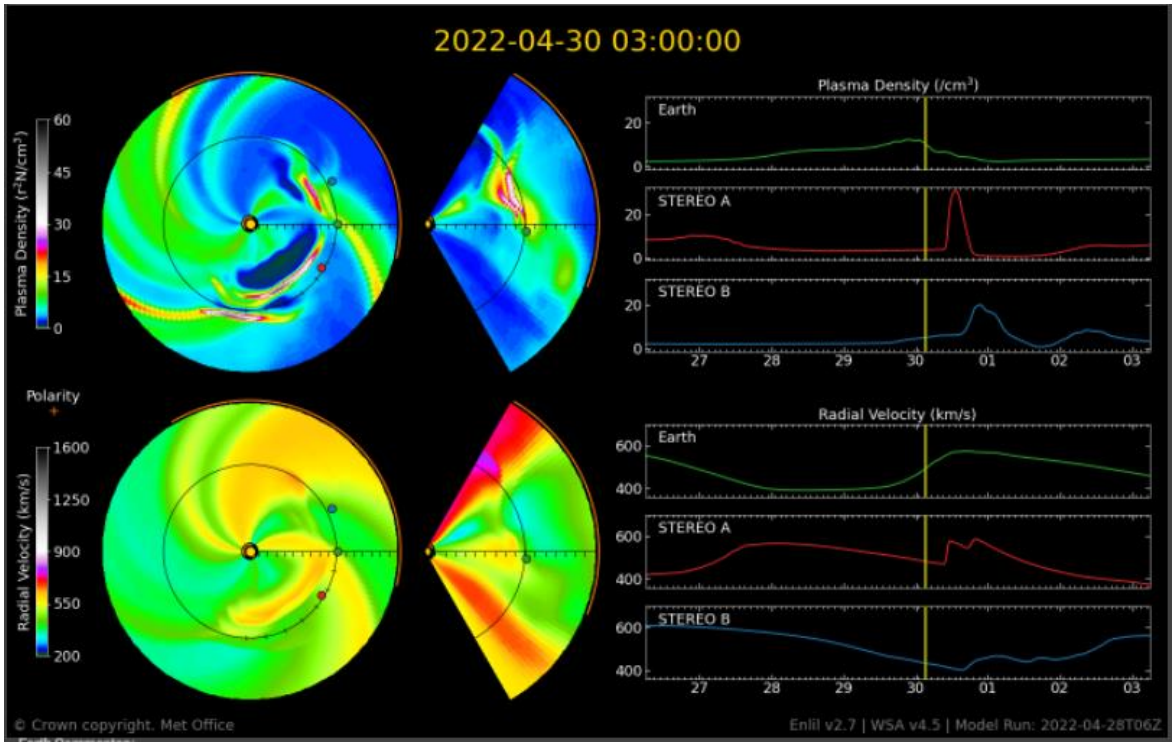
Figure 2: Enlil output showing potential CME arrival on 30th.



Radio Blackouts - X-Ray Flares:

Solar activity is expected to be Low to Moderate over the next four days, with a very slight chance of High activity.
There are currently eight numbered sunspot regions on the visible disc. AR2994 in the far northwest remains the most complex, with a Beta-Gamma configuration. AR2993 also appears to be slowly decaying as it begins to rotate off the earth-facing disc. AR2997 is a simple, but rather long bi-polar region in the northern hemisphere. AR2995, 2999, 3000, 3001, and 3002 all appear to be stable unipolar regions. There are two further possible small, weak groups towards the far northeast and southeast limb which are currently un-numbered.

A number of filaments are being monitored for potential eruptions, especially in the western hemisphere which could result in an Earth-directed CME.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	20	20	10
Very Active	R3 to R5 X Class	No	5	5	3	3

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at background levels, and is most likely to remain so through the next four days. However, AR2994 brings a none-zero chance of isolated proton storms from it's slightly inflated flare risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) is expected to vary between background and moderate levels on 28 April in a benign solar wind environment. The CIR ahead of the next high speed stream (Coronal Hole 78) is then likely to compress the radiation belts and redistribute electrons, leading to a drop in the flux. A possible CME arrival early 30th may then also reduce the electron field further, perhaps with a recovery in counts possible by 01 May.

Electron fluence values are likely to remain below the Active threshold (1e8 integrated pfu) through the period, but with a rising trend toward the end of the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	2	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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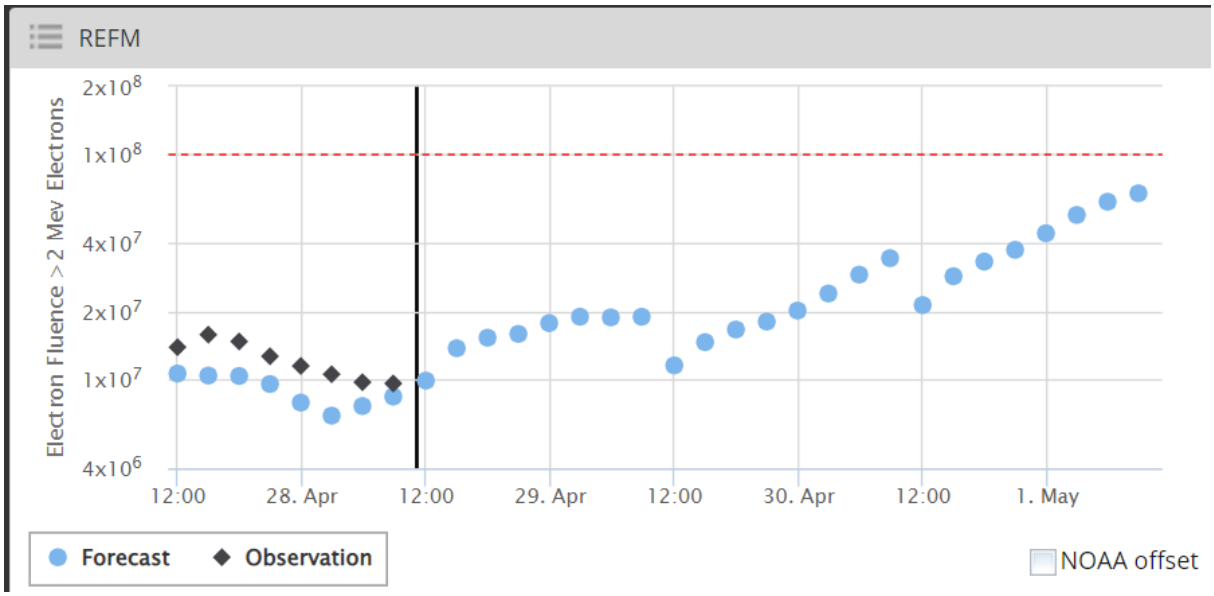
Figure 3: MOSWOC REFM



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